

RCAP RECEIVED



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*Transmitted by E-Mail*

To: Joe Haake  
From: Atul M. Salhotra, Ph.D.  
Sungmi Moon, Ph.D.  
Kendall L. Pickett  
Date: November 1, 2010

**RE: TPH Risk for Outdoor Inhalation of Vapors from Groundwater by Construction Worker in Sub-area 3C  
Boeing Tract 1 Facility, St. Louis, Missouri**

This memo presents the updated risk due to total petroleum hydrocarbons (TPHs) in groundwater for outdoor inhalation pathway by construction worker in Sub-area 3C at the Boeing Tract 1 Facility in St. Louis, Missouri. This update is necessary because in the *Risk-Based Corrective Action (RBCA) Report* (RAM Group, September 2004) the representative groundwater concentrations were inadvertently not capped at the constituent solubility levels. Also refer to the memo titled *Risk Evaluation of TPH for Indoor Inhalation Pathway* (RAM Group, January 12, 2010).

The representative groundwater concentrations used in Sub-area 3C are presented in Table 1 and are compared with the solubility values. The representative groundwater concentrations exceeding the solubility levels were replaced with the solubility and hazard quotient (HQs) were recalculated. These are presented in Table 2.

Table 3 presents the updated cumulative risks (hazard index (HI)) for construction worker in Sub-area 3C. The results indicate that the HI is 0.024 and are acceptable.

Upon receipt of approval by MDNR, this memo will be included as an appendix in the Corrective Measures Study.

If you have any questions, please let us know.

**References**

RAM Group, September 2004. Risk-Based Corrective Action (RBCA) Report, Boeing Tract 1 Facility, St. Louis, Missouri.

RAM Group, January 12, 2010. Risk Evaluation of TPH for Indoor Inhalation Pathway, Boeing Tract 1 Facility, St. Louis, Missouri.

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**Table 1**  
**Comparison of TPH Groundwater Representative Concentrations with Solubility in Sub-area 3C**  
**Boeing Tract 1, St. Louis, Missouri**

<b>TPH Groups and Carbon Fractions</b>	<b>Solubility (ug/L)</b>	<b>Rep. GW Conc. (ug/L)</b>	<b>Ratio of Rep. GW Conc. / Solubility</b>
Aliphatics > nC6 to nC8	5.40E+03	1.90E+04	3.5
Aliphatics > nC8 to nC10	4.30E+02	1.90E+04	44
Aromatics > nC8 to nC10	6.50E+04	1.90E+04	0.3
<b>TPH-GRO</b>			
Aliphatics > nC10 to nC12	3.40E+01	4.01E+04	1,179
Aliphatics > nC12 to nC16	7.60E-01	4.01E+04	52,734
Aliphatics > nC16 to nC21	2.50E-03	4.01E+04	16,031,133
Aromatics > nC10 to nC12	2.50E+04	4.01E+04	1.6
Aromatics > nC12 to nC16	5.80E+03	4.01E+04	6.9
Aromatics > nC16 to nC21	6.50E+02	4.01E+04	62
<b>TPH-DRO</b>			
Aliphatics > nC21 to nC35	2.50E-03	1.48E+04	5,913,800
Aromatics > nC21 to nC35	6.60E+00	1.48E+04	2,240
<b>TPH-ORO</b>			

Notes:

ug/L: Micrograms per liter

Ratio > 1: Representative groundwater concentration is higher than solubility and has to be set equal to solubility.

Rep. GW Conc.: Representative groundwater concentration

**Table 2**  
**Risk Calculation of Carbon Fractions for Outdoor Inhalation of Vapors from Groundwater by Construction Worker in Sub-area 3C**  
**Boeing Tract 1, St. Louis, Missouri**

TPH Groups and Carbon Fractions	Updated GW Concentration ( $\mu\text{g/L}$ )	HQ for Outdoor Inhalation of Vapors from Groundwater	
		2004 RA	Updated
Aliphatics > nC6 to nC8	5.40E+03	2.22E-04	6.29E-05
Aliphatics > nC8 to nC10	4.30E+02	6.51E-03	1.47E-04
Aromatics > nC8 to nC10	1.90E+04	2.56E-04	2.56E-04
<b>TPH-GRO</b>		<b>6.99E-03</b>	<b>4.66E-04</b>
Aliphatics > nC10 to nC12	3.40E+01	2.06E-02	1.74E-05
Aliphatics > nC12 to nC16	7.60E-01	8.90E-02	1.69E-06
Aliphatics > nC16 to nC21	2.50E-03	8.39E-01	5.23E-08
Aromatics > nC10 to nC12	2.50E+04	2.48E-04	1.54E-04
Aromatics > nC12 to nC16	5.80E+03	1.71E-04	2.48E-05
Aromatics > nC16 to nC21	6.50E+02	1.30E-04	2.12E-06
<b>TPH-DRO</b>		<b>9.49E-01</b>	<b>2.01E-04</b>
Aliphatics > nC21 to nC35	2.50E-03	3.09E-01	5.23E-08
Aromatics > nC21 to nC35	6.60E+00	2.85E-05	1.27E-08
<b>TPH-ORO</b>		<b>3.09E-01</b>	<b>6.50E-08</b>
<b>Total TPH</b>		<b>1.27E+00</b>	<b>6.67E-04</b>

Notes:

HQ: Hazard quotient

TPH: Total petroleum hydrocarbon

DRO: Diesel range organic

GRO: Gasoline range organic

ORO: Oil range organic

$\mu\text{g/L}$ : Micrograms per liter

GW: Groundwater

**Table 3**  
**Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Future Construction Worker in Sub-area 3C**  
**Boeing Tract 1, St. Louis, Missouri**

COCs	Average Soil Cone. (ug/kg)	Dermal Contact with Soil		Accidental Ingestion of Soil		Outdoor Inhalation of Vapors and Particulates from Soil		Average GW Conc. (ug/L)	Dermal Contact with Groundwater		Outdoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
		IELCR	HQ	IELCR	HQ	IELCR	HQ		IELCR	HQ	IELCR	HQ		
Acetone	32	NA	1.12E-07	NA	1.18E-07	NA	2.77E-07	---	---	---	---	---	NA	5.07E-07
Benzene	79	1.14E-11	9.15E-06	1.26E-11	1.02E-05	6.46E-11	9.17E-05	120	2.31E-08	1.86E-02	2.10E-11	2.98E-05	2.32E-08	1.87E-02
Isopropylbenzene	17	NA	6.04E-08	NA	6.72E-08	NA	4.20E-07	---	---	---	---	---	NA	5.48E-07
Methylene chloride	22	8.15E-13	1.27E-07	9.05E-13	1.41E-07	1.36E-12	6.72E-08	---	---	---	---	---	3.08E-12	3.35E-07
Methyl tert-butyl ether	14	2.35E-13	5.81E-09	2.62E-13	6.45E-09	9.05E-14	2.11E-08	35	1.64E-10	4.04E-06	3.44E-14	8.00E-09	1.65E-10	4.09E-06
n-Butylbenzene	22	NA	6.51E-07	NA	2.17E-07	NA	2.37E-07	208	NA	NA	NA	3.31E-06	NA	4.41E-06
n-Propylbenzene	30	NA	1.03E-05	NA	1.15E-05	NA	5.44E-07	223	NA	NA	NA	2.99E-06	NA	2.54E-05
sec-Butylbenzene	24	NA	6.92E-07	NA	2.31E-07	NA	3.39E-07	172	NA	NA	NA	3.65E-06	NA	4.91E-06
t-Butylbenzene	5.7	NA	1.65E-07	NA	5.49E-08	NA	6.64E-08	---	---	---	---	---	NA	2.86E-07
Toluene	656	NA	1.14E-07	NA	1.27E-06	NA	7.21E-06	---	---	---	---	---	NA	8.59E-06
Xylenes, Total	259	NA	4.52E-08	NA	4.62E-08	NA	1.03E-06	---	---	---	---	---	NA	1.12E-06
<b>Organics Total Risk</b>		<b>1.24E-11</b>	<b>2.15E-05</b>	<b>1.38E-11</b>	<b>2.38E-05</b>	<b>6.60E-11</b>	<b>1.02E-04</b>		<b>2.33E-08</b>	<b>1.86E-02</b>	<b>2.10E-11</b>	<b>3.98E-05</b>	<b>2.34E-08</b>	<b>1.88E-02</b>
TPH-GRO	47,350	NA	NA	NA	2.15E-04	NA	2.79E-04	24,847	NA	NA	NA	4.66E-04	NA	9.61E-04
TPH-DRO	311,290	NA	6.87E-04	NA	2.09E-03	NA	5.97E-04	31,485	NA	NA	NA	2.01E-04	NA	3.57E-03
TPH-ORO	33,290	NA	8.48E-05	NA	2.18E-04	NA	6.87E-06	6.6	NA	NA	NA	6.50E-08	NA	3.10E-04
<b>TPH Total Risk</b>		<b>NA</b>	<b>7.71E-04</b>	<b>NA</b>	<b>2.52E-03</b>	<b>NA</b>	<b>8.83E-04</b>		<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>6.67E-04</b>	<b>NA</b>	<b>4.84E-03</b>
<b>CUMULATIVE RISK</b>		<b>1.24E-11</b>	<b>7.93E-04</b>	<b>1.38E-11</b>	<b>2.54E-03</b>	<b>6.60E-11</b>	<b>9.85E-04</b>		<b>2.33E-08</b>	<b>1.86E-02</b>	<b>2.10E-11</b>	<b>7.07E-04</b>	<b>2.34E-08</b>	<b>2.36E-02</b>

Notes:

NA: Not available

---: Risk evaluation was not performed.

HI: Hazard index

TPH: Total petroleum hydrocarbon

DRO: Diesel range organic

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		IELCR	HQ	IELCR	HQ	IELCR	HQ		IELCR	HQ	IELCR	HQ			
Acetone	32	NA	1.12E-07	NA	1.18E-07	NA	2.77E-07	---	---	---	---	---	NA	5.07E-07	
Benzene	79	1.14E-11	9.15E-06	1.26E-11	1.02E-05	6.46E-11	9.17E-05	120	2.31E-08	1.86E-02	2.10E-11	2.98E-05	2.32E-08	1.87E-02	
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Methyl tert-butyl ether	14	2.35E-13	5.81E-09	2.62E-13	6.45E-09	9.05E-14	2.11E-08	35	1.64E-10	4.04E-06	3.44E-14	8.00E-09	1.65E-10	4.09E-06	
n-Butylbenzene	22	NA	6.51E-07	NA	2.17E-07	NA	2.37E-07	208	NA	NA	NA	NA	3.31E-06	NA	4.41E-06
n-Propylbenzene	30	NA	1.03E-05	NA	1.15E-05	NA	5.44E-07	223	NA	NA	NA	NA	2.99E-06	NA	2.54E-05
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Xylenes, Total	259	NA	4.52E-08	NA	4.62E-08	NA	1.03E-06	---	---	---	---	---	NA	1.12E-06	
<b>Organics Total Risk</b>		<b>1.24E-11</b>	<b>2.15E-05</b>	<b>1.38E-11</b>	<b>2.38E-05</b>	<b>6.60E-11</b>	<b>1.02E-04</b>		<b>2.33E-08</b>	<b>1.86E-02</b>	<b>2.10E-11</b>	<b>3.98E-05</b>	<b>2.34E-08</b>	<b>1.88E-02</b>	
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<b>TPH Total Risk</b>		<b>NA</b>	<b>7.71E-04</b>	<b>NA</b>	<b>2.52E-03</b>	<b>NA</b>	<b>8.83E-04</b>		<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>6.67E-04</b>	<b>NA</b>	<b>4.84E-03</b>
<b>CUMULATIVE RISK</b>		<b>1.24E-11</b>	<b>7.93E-04</b>	<b>1.38E-11</b>	<b>2.54E-03</b>	<b>6.60E-11</b>	<b>9.85E-04</b>		<b>2.33E-08</b>	<b>1.86E-02</b>	<b>2.10E-11</b>	<b>7.07E-04</b>	<b>2.34E-08</b>	<b>2.36E-02</b>	

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